# Report on Piloting of the Volute Dewatering Press at the West Goshen Township Wastewater Treatment Plant in West Chester, PA

## December 17th – 19th, 2014


PWTech

PROCESS WASTEWATER TECHNOLOGIES LLC

Process Wastewater Technologies, LLC.
9004 Yellow Brick Road, Suite D, Rosedale, MD 21237
Phone: 410-238-7977, Fax: 410-238-7559

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|---|---|
| Pilot Operator: | Ron Baker / Rich Hunt / Walker Keel |
| Report Prepared by: | Rich Hunt |
| Manufacturer's Representative: | Bill LaPorte – Envirep, Inc. |

# Summary

- The Volute Dewatering Press ES201 trailer mounted pilot unit was tested at the WGTWWTP in West Chester, PA on the plant's anaerobically digested sludge.
- The press produced cake solids results up to 30.6% dry solids.
- Solids capture rates were as high as 99.4%.

# Contents

# 1. Introduction

The Volute Dewatering Press model ES201 was pilot tested at the West Goshen Township Wastewater Treatment Plant (WGTWWTP) in West Chester, PA to determine its effectiveness at dewatering the plant's anaerobically digested sludge.

The WGTWWTP collects an average of 6.0 million gallons per day (MGD) of wastewater from the surrounding area. Treatment begins at the headworks for initial screening followed by an equalization basin and primary clarification. Effluent from the primary clarifiers is sent through a series of trickling filters, an aeration basin, and secondary/tertiary clarification. Effluent from the final clarifiers is disinfected with UV light.

Waste activated sludge (WAS) from the secondary and tertiary clarifiers is returned to the primary clarifier. Blended primary sludge and WAS from the primary clarifier is sent to a series of anaerobic digesters. The anaerobically digested sludge is dewatered using two 2.2 meter Ashbrook type 85 Klampress belt presses, rated at 80 GPM @ 3% solids, or 170 GPM @ <1% solids. Cake from the belt presses is typically around 16-18% solids and is placed in a dumpster to be hauled offsite to a local landfill. Pressate from the belt presses is recycled back to the plant headworks.

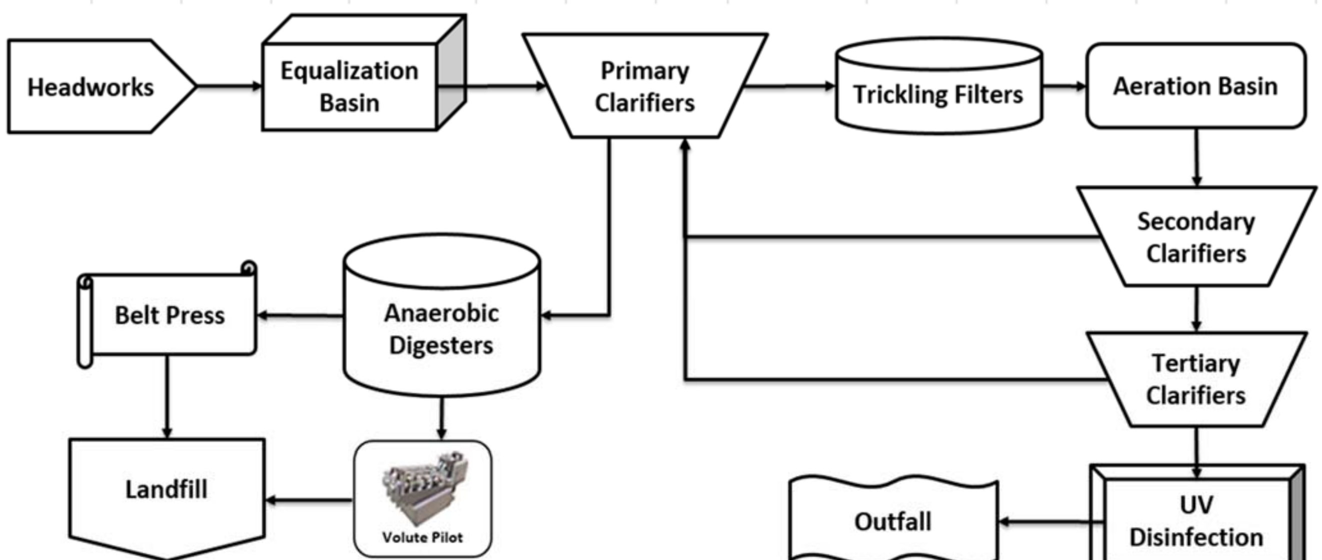


**Figure 1. Basic process layout of the West Goshen WWTP showing the location of the Volute Dewatering Press in the plant.**

The WGTWWTP is considering implementing a new dewatering process as an alternative to scheduled ten year maintenance on the plant's two belt presses. The Volute Dewatering

Press is a potential option due to its efficient dewatering capabilities, low maintenance requirements, fully automated operation, and low energy consumption.

## 2. Objective

To demonstrate the effectiveness of the Volute Dewatering Press at dewatering the plant's combined primary and waste activated sludge. The main objective is to demonstrate the efficiency and performance of the press to provide confidence in the Volute Dewatering Press as a replacement for the plant's belt presses. The Volute Dewatering Press should be capable of delivering significantly higher cake solids than the current belt presses. The pilot test should also demonstrate the low energy cost and maintenance required to operate the Volute Dewatering Press.

## 3. Pilot Set-up

The Volute pilot unit was set up adjacent to the sludge dewatering building. Power and water were supplied from within the building via a hose and 30 amperage circuit. A submersible pump supplied sludge to the press from a holding tank within the dewatering building. A progressive cavity pump at the base of the unit supplied sludge to the dewatering press at varying rates determined by the operator.

Cake solids were emptied into a bucket loader and periodically sent to the dumpster used to remove solids from the two belt presses. Pressate was gravity drained into the drain used by the belt presses, and from there sent back to the plant headworks.


**Figure 2. Solids being discharged from press into bucket loader**

# 4. Testing and Sample Analysis

After the unit was set up and operating smoothly, the process of testing for optimal conditions began. Several parameters were altered by the operator to obtain a spread of data for analysis and determine ideal operating conditions. Performance was tested to determine cake dryness and the percentage of solids removed from the process, while also ensuring the unit was able to perform at near-maximum capacity on the incoming sludge.

Controllable Parameters:

- Feed sludge flow rate
- Endplate gap – the gap between the rotating plate and the end of the dewatering drum through which the cake is discharged.

- Screw speed – rotational speed of screw in dewatering drum.
- Flash tank mixing speed – rotational speed of mixing unit in flash (initial) tank
- Flocculation tank mixing speed – rotational speed of mixing unit in flocculation tank
- Polymer type – Ciba Zetag 8848FS and Ashland K279FLX were tested.
- Polymer dose

In order to determine the effectiveness of the unit, samples were taken approximately one hour after making changes to the operating parameters and analyzed. These samples included:

- Feed solids – measured as total residual solids (TS) in percent [% w/w]
- Cake solids – measured as total residual solids (TS) in percent [% w/w]
- Pressate solids – measured as total suspended solids (TSS) in mg/L

Feed and cake solids tests were done on site using a Sartorius Moisture Analyzer, which measures the cake solids concentration to 0.1%. It functions by recording the initial weight of the sample, heating it until the change in weight drops below -1 mg per 60 seconds, and then recording the final “dry” weight and using the formula below, calculates total % solids.

Total % Solids = 100* (A / B)
Where A is the weight of the dry sample and B is the weight of the wet sample.

Pressate samples were taken from the pressate outflow from the pilot unit and sent to a lab to analyze the TSS content.

The polymer supplied by PWTech was a cationic emulsion polymer and was shipped to the site in 5 gallon pails. 14 runs used Ciba Zetag 8848FS, a 39% active polymer in solution that has a bulk price of $1.81 per pound. 7 runs used Ashland Praestol K279FLX, a 43% active polymer in solution that has a bulk price of $1.51 per pound. The polymer activation system mounted on the skid blended the raw polymer in the pails into a dilute solution that is then mixed with the sludge to achieve flocculation.

# 5. Results and Discussion

The pilot test of the ES201 was conducted over the course of 3 days with 20 unique tests runs performed. Volute settings were adjusted to find cake solids percentage and solids capture rates under a variety of conditions. Influent ranged from 1.4-2.6% solids with an average of 1.9% solids for all runs. Influent was relatively steady on the first day, and varied by up to .9% per day throughout the remainder of the pilot test. The extreme variance in the influent solids provided a challenging test environment that allowed the simplicity of operation of the Volute Dewatering Press to be displayed; due to unexpected illness of the primary

PWTech technician, the pilot unit was often operated by a trainee with less than a day of experience, yet achieved cake solids results significantly higher than the belt presses currently in use. As the standard PWTech startup procedure calls for a one week onsite training and calibration visit by PWTech engineers, actual results by an experienced press operator should also be significantly higher than can be achieved using the currently installed belt presses.

### 5.1. Cake Solids

Percent solids of the pressed cake was measured for each run by PWTech, with spot-checking by the WGTWWTP lab technician that confirmed the PWTech results. Results from the Volute Dewatering Press ranged from 16.8% to 30.6% with an average of 21.9%.

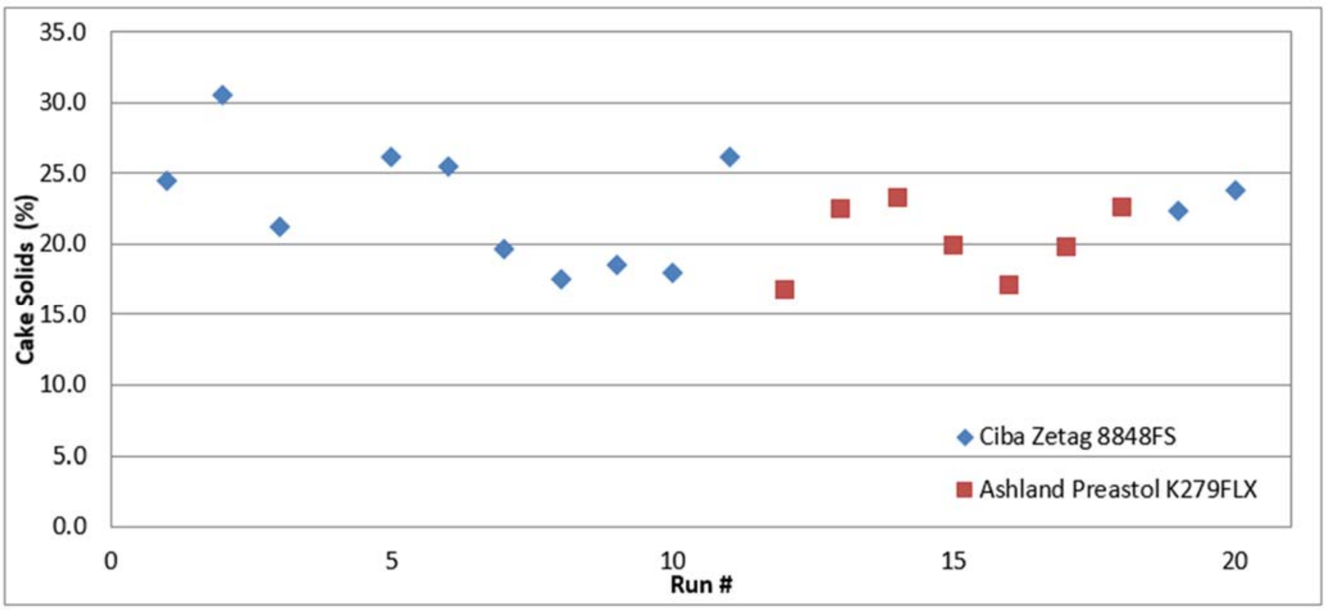


**Figure 3. Cake solids results for each run.**

The main objective was to produce significantly drier solids than the plant's current belt presses, while also proving the Volute Dewatering Press's capability to operate at near-maximum capacity without significant reduction of solids percentage. Currently, the belt presses produce cake with an average of 16-18% solids. The lowest runs by the test unit were comparable to the typical run from the belt presses, while the highest runs were nearly double the solids percentage from the belt presses. While running at 94% of rated solids capacity, the Volute Dewatering Press pilot unit was able to achieve 23.8% cake solids. Assuming a 17% average cake solids from current equipment, the Volute Dewatering Press would reduce outgoing wet tons by 29% when run at near-maximum solids capacity, or up to 45% if run at reduced throughput.

## 5.2. Polymer Use

Two types of polymer were used throughout the pilot test at varying doses; Ciba Zetag 8848FS and Ashland Praestol K279FLX. 7 runs were performed using Ashland Praestol K279FLX, the driest cake solids result was 23.2% solids with an average of 19.9%. 13 runs were performed using the Ciba Zetag 8848FS, the driest cake solids result was 30.6% with an average of 22.8%.

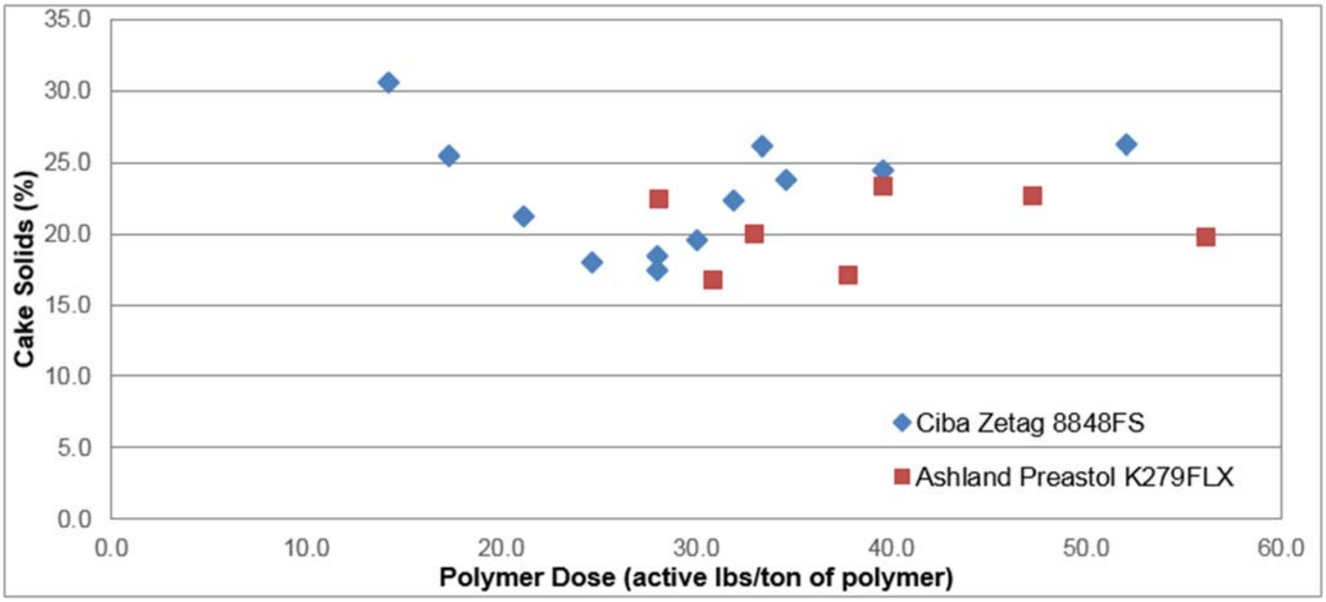


**Figure 4. Polymer dose vs cake solids results for each run.**

The Ciba Zetag 8848FS polymer performed better on average and flocculated better at higher doses of polymer, although dose rates above 40 lbs/ton had minimal effect. The Ciba Zetag 8848FS polymer also produced the driest cake solids result of 30.6% using a polymer dose of 14.3 active pounds per ton of dry solids, however doses under 20 active pounds per ton present significant risk of losing flocculation due to the highly variable influent solids percentage. Ideal polymer doses were between 33 and 40 active pounds of polymer per dry ton of solids to achieve high cake dryness without risk of losing flocculation.

## 5.3. Solids Capture

Solids capture performance was assessed for each run based on TSS results. Overall, there was a peak value of 99.4% removal of solids. Solids capture results ranged from 92.5% to 99.4%, with an average value of 96.9%. The vast majority of results for the pilot achieved solids capture rates of at least 96%. Six unique test runs were above 98% capture rate which would exemplify typical operation running the press at suggested settings for optimal results.

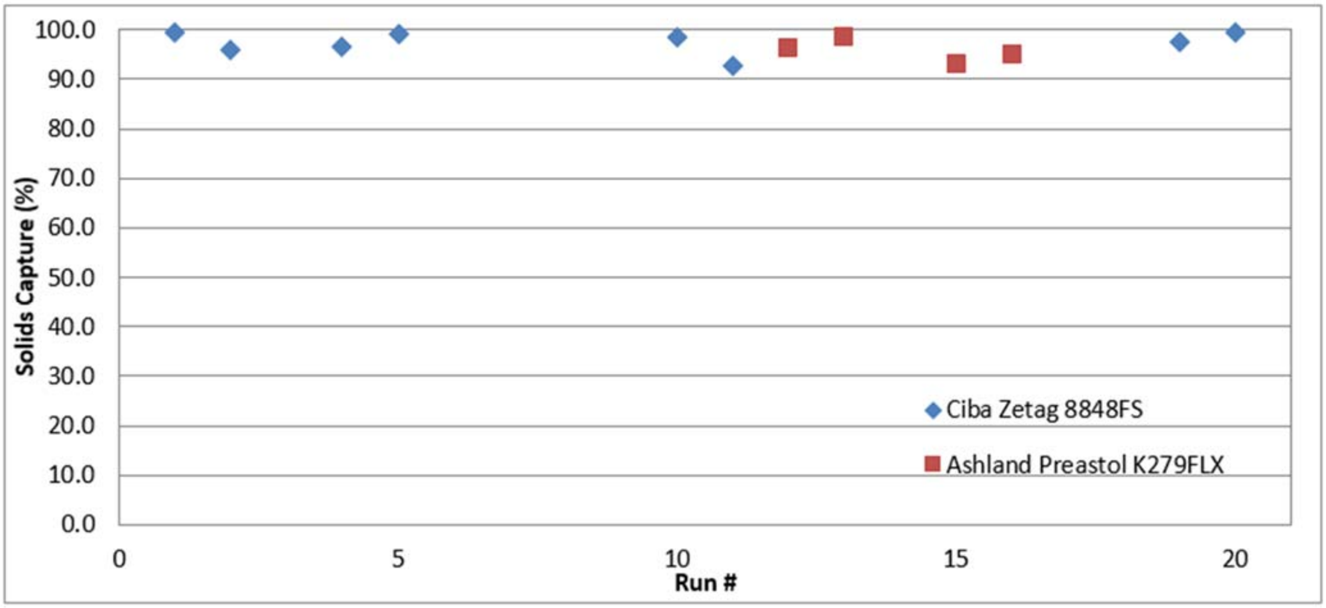


**Figure 5. Solids capture results.**

# 6. Conclusion

The Volute Dewatering Press ES201 trailer mounted pilot unit was tested at the West Goshen Wastewater Treatment Plant in West Chester, PA on the plant's digested combined primary and waste activated sludge. The objective was to demonstrate the capabilities of the Volute Dewatering Press as a cost-effective option to replace the plant's 2.2 meter belt presses, as an alternative to additional capital investments in the belt presses as part of the current regular maintenance cycle.

The press generated cake solids as dry as 30.6% and achieved solids capture rates as high as 99.4%. Cake disposal costs can be expected to fall 29% to 46%. Operator maintenance requirements will also see significant reductions.

Based on the results of this pilot, the Volute Dewatering Press was found to be a suitable replacement for the plant's belt presses.

# 7. Acknowledgments

PWTech extends its gratitude to John Scott, Mike Gillespie and the staff at the West Goshen Wastewater Treatment Plant for their assistance in running this pilot test.

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# Appendix –All Results

| Run | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | | 12/17/14 | | | | 12/18/14 | | | | | | | 12/19/14 | | | | | | | | |
| **Unit Parameters** | | | | | | | | | | | | | | | | | | | | | |
| Endplate gap | [mm] | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Drum Screw Speed | [RPM] | 1.0 | 0.7 | 0.7 | 0.7 | 0.7 | 1.0 | 1.0 | 1.0 | 1.0 | 0.7 | 0.5 | 0.7 | 0.7 | 0.7 | 1.9 | 2.4 | 2.9 | 1.2 | 1.2 | 2.9 |
| Flocculation Mixer Speed | [RPM] | 25 | 25 | 25 | 25 | 28 | 28 | 28 | 28 | 28 | 28 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 15 | 15 | 15 |
| Flow | [gpm] | 1.7 | 1.7 | 1.7 | 2.7 | 2.2 | 2.2 | 2.2 | 2.5 | 2.5 | 2.5 | 2 | 2 | 2 | 2 | 4 | 5 | 6 | 3 | 3 | 6 |
| **Chemical Dosing** | | | | | | | | | | | | | | | | | | | | | |
| Polymer | | Ciba Zetag 8848 FS | | | | | | | | | | | Ashland Preastol K279FLX | | | | | | | Ciba Zetag 8848FS | |
| Raw Polymer Flow | [mL/min] | 5 | 1.8 | 2.5 | 2.5 | 9.46 | 3.15 | 5 | 5.68 | 5.68 | 5.68 | 6.94 | 5.04 | 6.3 | 7.57 | 12.62 | 17.67 | 25.23 | 11.99 | 11.99 | 25.23 |
| Percent Active | [%] | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 39 | 39 |
| Cost Per pound | [$] | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.81 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.81 | 1.81 |
| Active Polymer Dose Rate | [ppm] | 90 | 50 | 70 | 50 | 361 | 120 | 191 | 195 | 195 | 195 | 238 | 204 | 255 | 307 | 256 | 307 | 383 | 291 | 247 | 325 |
| **Solids Concentration** | | | | | | | | | | | | | | | | | | | | | |
| Influent Solids | [%] | 1.5 | 1.5 | 1.4 | 1.5 | 1.7 | 1.7 | 1.6 | 1.7 | 1.7 | 1.9 | 2.1 | 1.9 | 2.5 | 2.2 | 2.2 | 2.1 | 1.7 | 1.9 | 2.6 | 2.5 |
| Cake Solids | [%] | 24.4 | 30.6 | 21.3 | - | 26.2 | 25.5 | 19.6 | 17.5 | 18.5 | 18.0 | 26.1 | 16.8 | 22.5 | 23.2 | 19.9 | 17.1 | 19.7 | 22.6 | 22.3 | 23.8 |
| Pressate Solids | [mg/L] | 100 | 620 | - | 490 | 160 | - | - | - | - | 300 | 1600 | 730 | 420 | - | 1500 | 1100 | - | 500 | 150 | 350 |
| **Calculated Parameters** | | | | | | | | | | | | | | | | | | | | | |
| Solids Throughput | [#/hour] | 13 | 13 | 12 | 20 | 19 | 19 | 17 | 21 | 21 | 24 | 21 | 18 | 25 | 22 | 43 | 53 | 51 | 29 | 39 | 75 |
| Solids Capture | [%] | 99.3 | 95.9 | - | 96.6 | 99.1 | - | - | - | - | 98.4 | 92.5 | 96.1 | 98.3 | - | 93.1 | 94.8 | - | 97.4 | 99.4 | 98.6 |
| Active Polymer Use | [lbs/ton] | 40 | 14 | 21 | 13 | 52 | 17 | 30 | 28 | 28 | 25 | 33 | 33 | 30 | 42 | 35 | 40 | 60 | 51 | 32 | 35 |
| **Polymer Cost** | | | | | | | | | | | | | | | | | | | | | |
| Total Cost per Ton | [$] | 184 | 66 | 98 | 61 | 242 | 80 | 139 | 130 | 130 | 114 | 155 | 109 | 99 | 139 | 116 | 133 | 197 | 166 | 148 | 161 |

**Figure 6. Results**

## Appendix -Table 1 Calculations Expanded

Active Polymer Use relates polymer used to solids generated. It is the ratio of active polymer used to solids throughput, and is commonly calculated as pounds of active polymer per dry ton of solids. In order to show this calculation, solids throughput and active polymer flow rate are calculated first. Sludge is assumed to have a specific gravity of 1.

Solids Throughput: calculated for one hour.

$$Sludge\ Flow\ Rate\ (gpm) * \ 60\frac{min}{hour} * 8.35\frac{lb}{gal} = lbs\ of\ sludge\ per\ hour$$

$$\frac{Influent\ Solids\ \%}{100} * \frac{lbs\ of\ sludge}{hour} = lbs\ of\ solids\ per\ hour$$

Active Polymer Flow for one hour is calculated from Raw Polymer Flow:

$$\frac{mLs\ of\ raw\ polymer}{min} * 60\frac{min}{hour} * \frac{\%\ active}{100} * 0.0022\frac{lbs}{mL} = lbs\ of\ active\ polymer\ per\ hour$$

Active Polymer Use is the ratio of Active Polymer Flow to Solids Throughput:

$$\frac{lbs\ of\ active\ polymer\ per\ hour}{ibs\ of\ solids\ per\ hour} * 2000\frac{lbs}{ton} = lbs\ of\ active\ polymer\ per\ dry\ ton\ of\ solids$$

Polymer Cost per Ton of Solids is calculated from Active Polymer Use and Solids Throughput:

$$\frac{(\frac{lbs\ of\ active\ polymer}{dry\ ton\ of\ solids})}{(\frac{\%\ active}{100})} = \ lbs\ of\ raw\ polymer\ per\ dry\ ton\ of\ solids$$

$$\frac{lbs\ of\ raw\ polymer}{dry\ ton\ of\ solids} * \frac{\$}{lbs\ of\ raw\ polymer} = \$\ per\ dry\ ton\ of\ solids$$

Example Calculations for run # 2:

Note: Numbers in the spreadsheet are rounded to the nearest tenth place and nearest integer to keep it neat and easily readable. Numbers may vary slightly from the example calculations below.

Solids throughput:

$$1.7\ gpm * 60\frac{min}{hour} * 8.35\frac{lbs}{gal} = 851.7\ lbs\ of\ sludge\ per\ hour$$

$$\frac{1.5\%}{100} * \frac{851.7\ lbs}{hour} = 12.8\ lbs\ of\ solids\ per\ hour$$

Active Polymer Flow for one hour is calculated from Raw Polymer Flow:

$$\frac{1.8\ mL}{min} * 60\frac{min}{hour} * \frac{39\%}{100} * 0.0022\frac{lbs}{mL} = 0.09\ lbs\ per\ hour$$

Active Polymer Use is the ratio of Active Polymer Flow to Solids Throughput:

$$\frac{0.09\ lbs\ polymer}{12.8\ lbs\ solids} * 2000\frac{lbs}{ton} = 14.1\ lbs\ of\ active\ polymer\ per\ dry\ ton\ of\ solids$$

Polymer Cost per Ton of Solids is calculated from Active Polymer Use and Solids Throughput:

$$\frac{\left(\frac{14.1\ lbs}{dry\ ton\ of\ solids}\right)}{\left(\frac{39\%}{100}\right)} = 36.2\ lbs\ of\ raw\ polymer\ per\ dry\ ton\ of\ solids$$

$$\frac{36.2\ lbs\ of\ raw\ polymer}{dry\ ton\ of\ solids} * \frac{\$1.81}{lbs\ of\ raw\ polymer} = \$66\ per\ dry\ ton\ of\ solids$$

**Figure 7. Cake Solids**